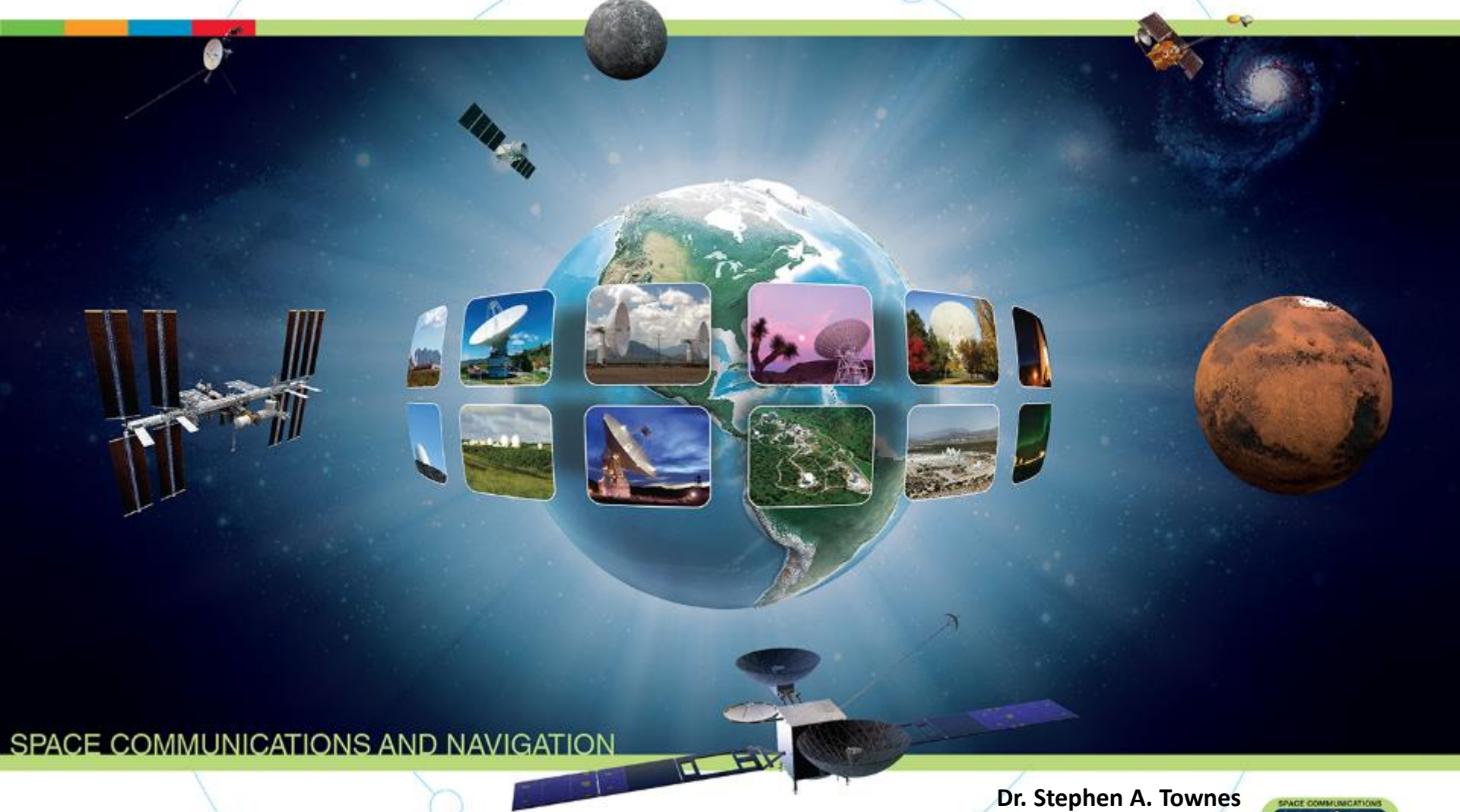


NASA's Optical Communications Program for 2017 and Beyond

National Aeronautics and
Space Administration



SPACE COMMUNICATIONS AND NAVIGATION

www.nasa.gov

Dr. Stephen A. Townes
Chief Technologist, Interplanetary Network Directorate
NASA Jet Propulsion Laboratory
California Institute of Technology



IAC 2017



Acknowledgement



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National Aeronautics and Space Administration*

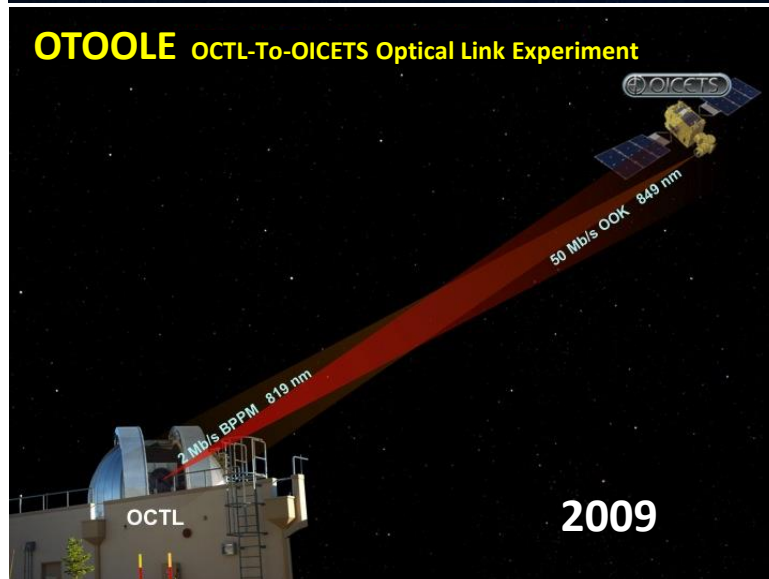
for providing much of the path forward information



Introduction



- NASA has been working on optical communication since at least the mid-1970s
- Communication for NASA science and exploration missions
- Next step beyond Ka-band
- Program elements
 - Technology and system development
 - Demonstration missions
 - Operational systems



➤ *Notably, NASDA/JAXA and NICT*

2013: NASA's First, Historic Lasercom Mission

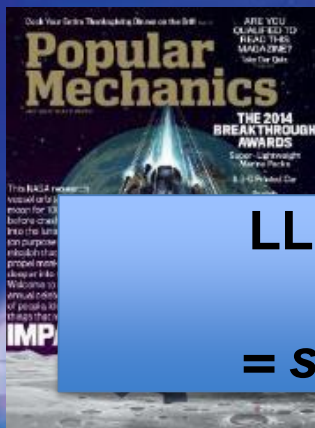


The Lunar Laser Communication Demonstration (LLCD)



MIT Lincoln Laboratory, NASA GSFC,
NASA Ames, NASA JPL, and ESA

2014 Popular Mechanics
Breakthrough Award for
Leadership and
Innovation for LADEE



2014 R&D 100
Winning Technology
in Communications
category



Nominated for the
National Aeronautic
Association's Robert J.
Collier Trophy



Winner of the
National Space
Club's Nelson P.
Jackson Award for
2015

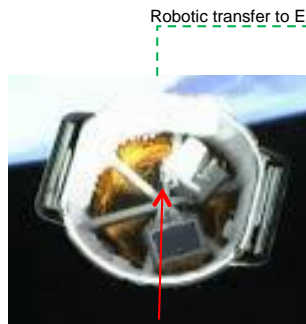


LLCD returned data by laser to Earth at a record
622 Megabits per second (Mbps)
= *streaming 30+ HDTV channels simultaneously!*

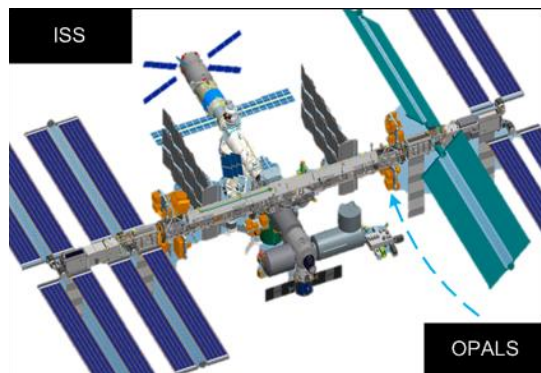


2014—OPALS

Optical **P**ayload for **L**asercomm **S**cience



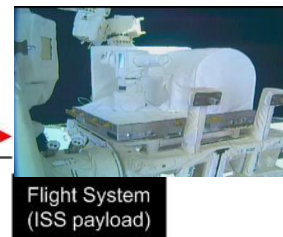
Robotic transfer to ELC-1 →



MOS Commands & Uploads

1553 bus

1553 bus
Telemetry & Health



Flight System
(ISS payload)

50 Mb/s
optical downlink
video

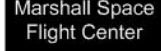
optical
beacon

MOS commands & Uploads
RF (TDRSS)

Telemetry & Health
RF (TDRSS)

MOS commands & Uploads
Internet (TReK)

Internet (TReK)
Telemetry & Data Queries



Marshall Space
Flight Center



Mission Operations
System

Telemetry & Link data
Internet

Internet

Voice commands/
ISS ephemeris predicts



OCTL

Installation Milestones:

- SpaceX CRS-3 Launch (4/18)
- Dragon Docked with ISS (4/20)
- OPALS Transfer and Installation (5/5-5/7)
- OPALS Initial Power On and Checkout (5/10)

Nominal Mission:

(Dependent on ISS schedule and TMF Visibility)

- Commissioning Phase (5/14-5/31)
- First Official Video Downlink (6/5)
- First Daytime Video Downlink (6/12)
- Low Elevation Transmissions (6/11-6/30)
- Power & Pointing Variation Testing (7/1-7/31)
- Foreign Ground Station Collaborations (8/1-9/15)

OPALS in Dragon trunk post separation



SpaceX CRS-3 Launch April 18, 2014



NASA's Plan Forward for Near-Earth Relay Optical Missions: LCRD in GEO



GEO Relay and Ground Terminal on ISS in 2021

- Gen-1 GEO Optical Relay Terminal
- Laser Communications Relay Demonstration (LCRD)

311 Mbps x 2 Return Links on RF
16 Mbps Forward Link on RF

- Gen-1 Optical User Terminal
- 1.244 Gbps Optical Return Link
51 Mbps Forward Link

Orion EM-2

Up to 531 Mbps PPM Return Link
20 Mbps Forward Link

Orion EM-2 from the Moon

1.244 Gbps
Optical Forward
And Return Link

SCaN
Operated
Gen-1 OGS

SCaN
Operated
Gen-1 OGS

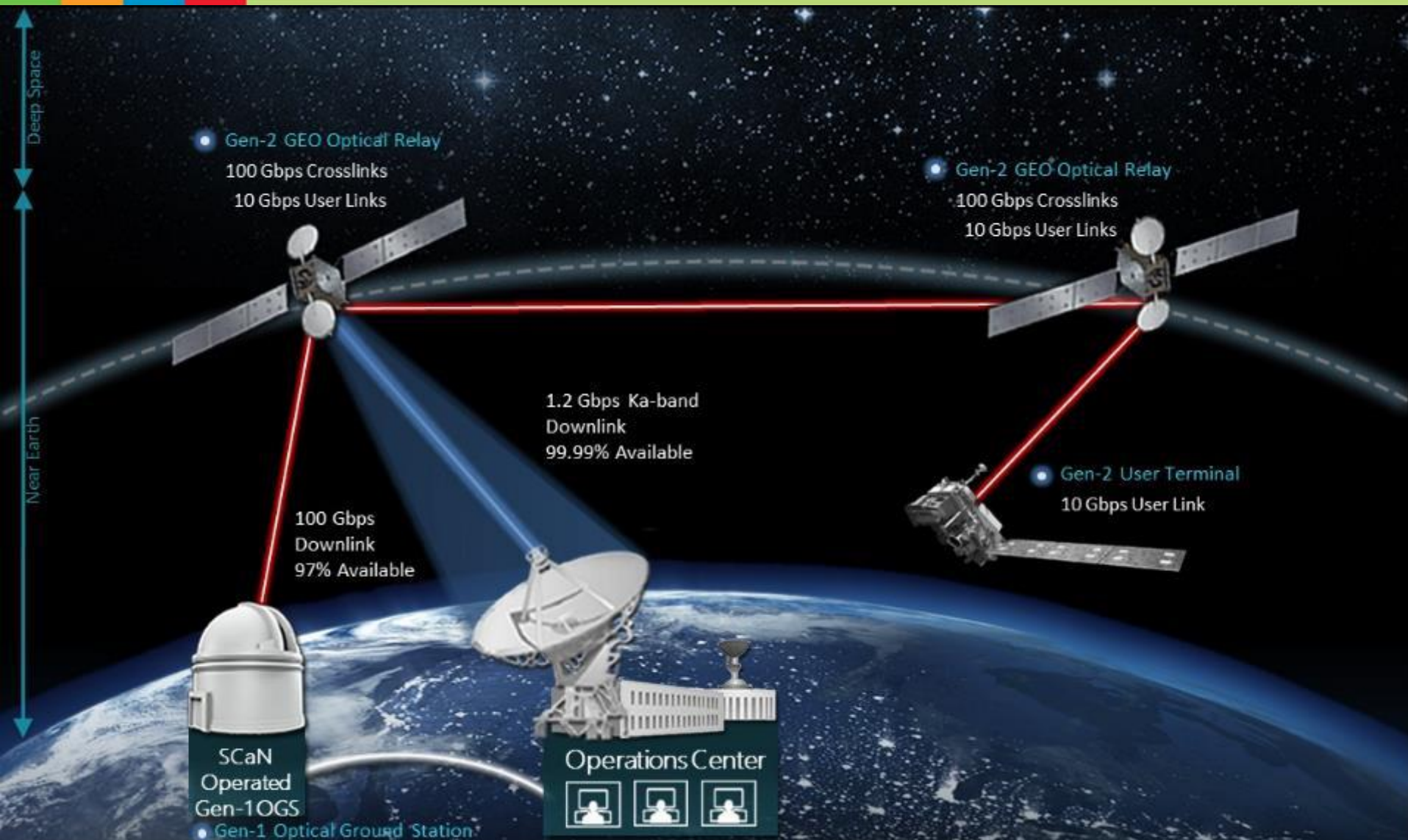
Operations Center



- Gen-1 Optical Ground Station

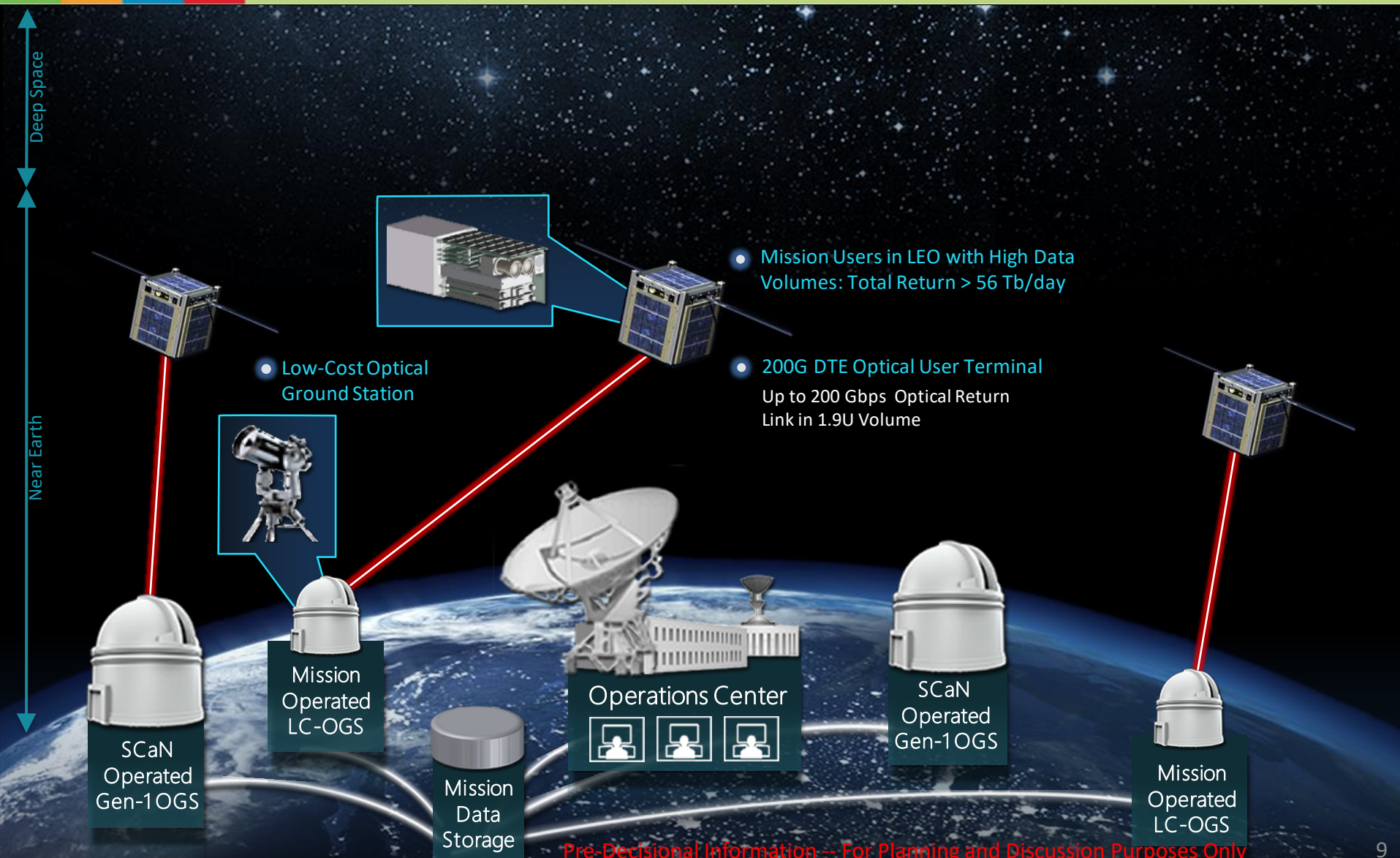


NASA's Next Gen Relay (2024) with 10G Users and 100G Crosslinks





NASA's Optical Plan Forward: Ultra-High Data Rate LEO Direct-to-Earth (DTE)

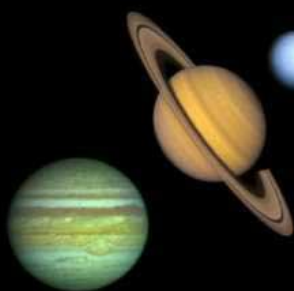


NASA's Optical Plan Forward: Deep Space Optical Communications



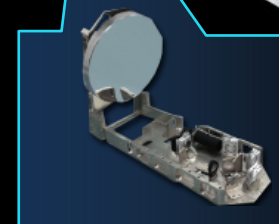
Deep Space

Near Earth



And beyond ...

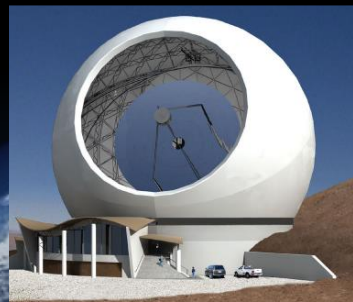
Planned Psyche Demo
DSOC Gen-1 Optical User Terminal
DSOC on Psyche Asteroid Mission 2023
125 Mbps from 40M km



DSOC Gen-1 Optical Ground Station



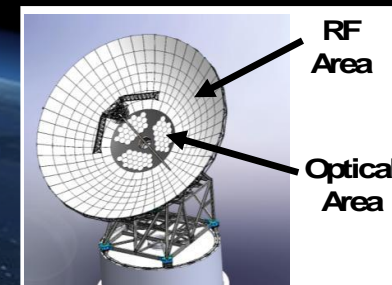
DSOC
Gen-1 OGS



New Build—12m
Segmented Spherical Primary



Operations Center



Hybrid RF-Optical Antenna

NASA is committed to infusion of optical communication into operational support of science and exploration missions

